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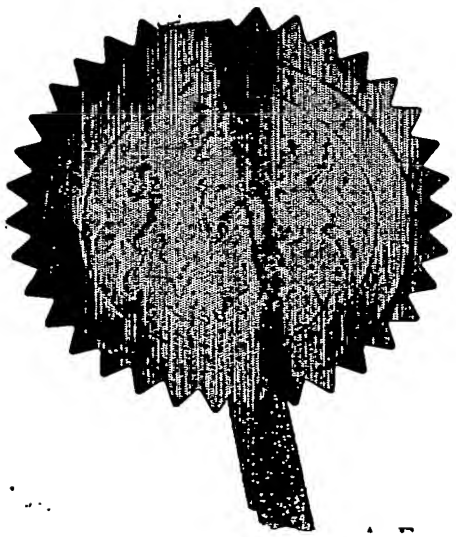

Signed

Dated 14 May 2004

Patents Form 1/77

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THE PATENT OFFICE
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11 JUL 2003
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11JUL03 E821856-1 D02934
P01/7700 0.00-0316237.7

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference 101058-1 GB

2. Patent application number *(The Patent Office will fill in this part)* 0316237.7 11 JUL 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

AstraZeneca AB
SE-151 85 Sodertalje
Sweden

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation Sweden 7822448003

4. Title of the invention

THERAPEUTIC AGENTS

5. Name of your agent *(if you have one)* Thomas Kerr MILLER

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

AstraZeneca UK Limited
Global Intellectual Property
Mereside, Alderley Park
Macclesfield,
Cheshire SK10 4TG

Patents ADP number *(if you know it)* 7822471002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	39
Claim *(s)*	3
Abstract	1
Drawing *(s)*	

10. If you are also filing any of the following, state how many against each item.

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Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 10/07/03

12. Name and daytime telephone number of person to contact in the United Kingdom: Jennifer Bennett - 01625 230148

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THERAPEUTIC AGENTS

Field of the invention

The present invention relates to certain novel, substituted 5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one and 1*H*-pyrrole-2,5-dithione derivatives, to processes for preparing such compounds, to their the utility in treating clinical conditions including atherosclerosis, lipid disorders (dyslipidemias) whether or not associated with insulin resistance and other manifestations of the metabolic syndrome, to methods for their therapeutic use and to pharmaceutical compositions containing them.

Background of the invention

Abnormalities of cholesterol and fatty acid homeostasis, that are reflected as diverse dyslipidemias, are causal of atherosclerosis and consequently cardiovascular disease (CVD). This disease is the major health problem in industrialized countries and is reaching the same prevalence in adults in developing nations. Most studies show that statins reduce LDL cholesterol by 25-30% and the relative risk of coronary events by approximately 30 %. While this beneficial effect is significant, effectively 70 % of the treated cohort remains with unchanged risk. This has prompted intense research in order to identify other common abnormalities of lipid metabolism that if efficiently treated could improve the results of current CVD therapy.

The nuclear hormone receptors LXR (Liver X Receptor) α and β use oxysterols as natural ligands. They appear to act as cholesterol sensors with target genes that are required for cholesterol efflux from macrophages, like ABCA1 and apoE as well as gene products, like cholestrol ester transferase protein (CETP) and phospholipid transport protein (PLTP), that are required for the function of HDL in the reverse cholesterol transport. In addition, LXR upregulates lipoprotein lipase in liver and macrophages, a function that may stimulate fatty acid uptake and VLDL remodeling. In the liver, LXR ligands seem to stimulate the hepatobiliary secretion of cholesterol, a pathway controlled by the membrane cassettes ABCG5 and ABCG8. The same cholesterol transporters appear to reduce cholesterol absorption in enterocytes, therefore influencing total body cholesterol balance. These

effects of LXR stimulation could explain its remarkable anti-atherosclerotic properties observed in several animal models.

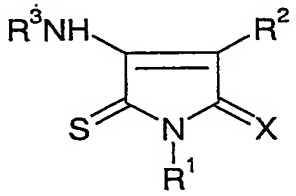
Recently the synthetic LXR ligands GW3965 (Glaxo) and T-0901317(Tularik)were reported to increase glucose tolerance in fat fed obese mouse which was interpreted to result from reduced hepatic gluconeogenesis and increased glucose uptake in adipocytes Lafitte BA et al. (Proc Natl Acad Sci U S A. 2003 Apr 29;100(9):5419-24). Activation of liver X receptor improves glucose tolerance through coordinated regulation of glucose metabolism in liver and adipose tissue.

WO00/21927 discloses pyrrole-2,5-diones which are GSK-3 inhibitors and claimed to be useful in the treatment of dementias, manic depression and diabetes. There is no suggestion that these compounds have activity as LXR agonists.

It is the object of the present invention to provide LXR agonists.

Description of the invention

According to a first aspect of the present invention there is provided a compound of the Formula I



Formula I

wherein:

$\mathbf{R^1}$ is selected from phenyl(1-4C)alkyl, pyridyl(1-4C)alkyl wherein the pyridyl is optionally substituted by amino or $\mathbf{R^1}$ is a (1-6C)alkyl group which is optionally substituted by one or more of the following: fluoro or (1-3C)alkoxy which is optionally substituted by one or more fluoro;

R^2 is phenyl;

R^3 is 4-morpholinophenyl or phenyl optionally substituted by one or more (1-4C)alkoxy groups wherein the alkoxy groups are optionally substituted by one or more fluoro;
and
X is O or S and pharmaceutically acceptable salts thereof.

Further values of R^1, R^2, R^3 and X in compounds of formula I now follow. It will be understood that such values may be used where appropriate with any of the definitions, claims or embodiments defined hereinbefore or hereinafter.

In a first group of compounds of formula I, X is O.

In a second group of compounds of formula I, X is S.

In a third group of compounds of formula I, R^1 is selected from methyl, ethyl, propyl, butyl, 2-methoxyethyl, 2,2,2-trifluoroethyl, benzyl, 4-pyridylmethyl, 3-pyridylmethyl or 2-amino-5-pyridylmethyl.

In a fourth group of compounds of formula I, R^3 is 4-methoxyphenyl, 4-difluoromethoxyphenyl or 4-morpholinophenyl

The compounds of formula I have activity as medicaments. In particular the compounds of formula I are LXR agonists.

Specifically the present invention provides a compound selected from:
1-(2-Methoxyethyl)-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;
1-(2-Methoxyethyl)-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;
4-[(4-Methoxyphenyl)amino]-3-phenyl-1-(pyridin-3-ylmethyl)-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dithione;
4-[(4-Methoxyphenyl)amino]-3-phenyl-1-(pyridin-4-ylmethyl)-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;
3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-4-ylmethyl)-1H-pyrrole-2,5-dithione;
1-Butyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;
1-Butyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;
4-[(4-Methoxyphenyl)amino]-3-phenyl-5-thioxo-1-(2,2,2-trifluoroethyl)-1,5-dihydro-2H-pyrrol-2-one;
3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(2,2,2-trifluoroethyl)-1H-pyrrole-2,5-dithione;
1-Benzyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;
1-Benzyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;
4-[(4-Methoxyphenyl)amino]-1-methyl-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one ;
3-[(4-Methoxyphenyl)amino]-1-methyl-4-phenyl-1*H*-pyrrole-2,5-dithione;
1-Ethyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;
1-Ethyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;
1-[(6-Aminopyridin-3-yl)methyl]-4-{[4-(difluoromethoxy)phenyl]amino}-3-phenyl-5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one;
1-[(6-Aminopyridin-3-yl)methyl]-3-{[4-(difluoromethoxy)phenyl]amino}-4-phenyl-1*H*-pyrrole-2,5-dithione;
1-[(6-Aminopyridin-3-yl)methyl]-4-[(4-morpholin-4-ylphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one and
1-[(6-aminopyridin-3-yl)methyl]-3-[(4-morpholin-4-ylphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dithione;
and pharmaceutically acceptable salts thereof.

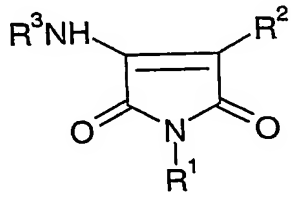
Certain compounds of the present invention may exist as tautomers. It is to be understood that the present invention encompasses all such tautomers.

Methods of preparation

The compounds of the invention may be prepared as outlined below. However, the invention is not limited to these methods. The compounds may also be prepared as

described for structurally related compounds in the prior art. The reactions can be carried out according to standard procedures or as described in the experimental section.

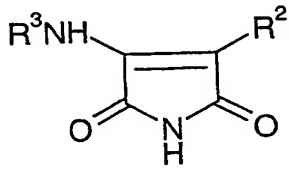
Compounds of formula I may be prepared by reacting a compound of formula II



II

in which R^1, R^2 and R^3 are as previously defined with a sulphurating agent, for example Lawesson's reagent, optionally in the presence of an inert organic liquid for example an aromatic hydrocarbon, e.g. toluene, at a temperature in the range of 0°C to 200°C. Compounds of formula I in which X is O may be prepared using an approximately molar equivalent of the sulphurating agent. Compounds of formula I in which X is S may be prepared using approximately two molar equivalents of the sulphurating agent.

Compounds of formula II may be prepared by reacting a compound of formula III



III

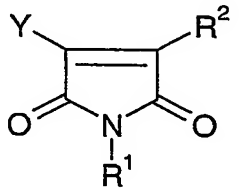
in which R^2 and R^3 are as previously defined with a compound of formula IV

R^1OH

IV

in which R^1 is as previously defined in the presence of a dialkyl azodicarboxylate, for example diethyl azodicarboxylate, and a phosphine, for example triphenylphosphine, optionally in the presence of an inert organic liquid for example an ether e.g. tetrahydrofuran at a temperature in the range of 0°C to 200°C.

Compounds of formula II may also be prepared by reacting a compound of formula V



V

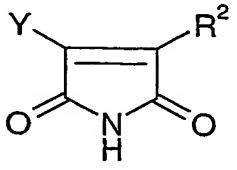
in which R^1 and R^2 are as previously defined and Y is a leaving group for example halo e.g. chloro with a compound of formula VI

$$R^3NH_2$$

VI

in which R^3 is as previously defined optionally in the presence of an inert organic liquid for example dimethylformamide and optionally in the presence of a base for example potassium carbonate at a temperature in the range of 0°C to 250°C.

Compounds of formula III may be prepared by reacting a compound of formula VII



VII

in which R^2 is as previously defined and Y is a leaving group for example halo eg chloro with a compound of formula VI

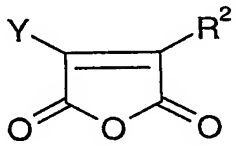
$$R^3NH_2$$

VI

in which R^3 is as previously defined optionally in the presence of an inert organic liquid for example dimethylformamide and optionally in the presence of a base for example triethylamine at a temperature in the range of 0°C to 250°C.

Compounds of formula IV and VI are commercially available or may be prepared by methods known to those skilled in the art.

Compounds of formula V may be prepared by reacting a compound of formula VIII



VIII

in which R^2 and Y are as previously defined with a compound of formula IX

R^1NH_2

IX

in which R^1 is as previously defined optionally in the presence of an organic liquid, for example glacial acetic acid at a temperature in the range of 0°C to 200°C.

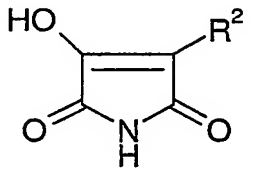
Compounds of formula V may also be prepared by reacting a compound of forumula VII with a compound of forumula XII

R^1L

XII

in which R^1 is as previously defined and L is a leaving group for example halo eg bromo in the presence of an inert organic liquid for example dimethylformamide and optionally in the presence of a base for example potassium carbonate at a temperature in the range of -78°C to 200°C.

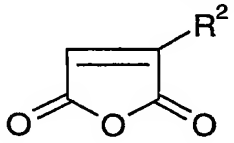
Compounds of formula VII may be prepared by reacting a compound of formula X



X

in which R^2 is as previously defined with a halogenating agent for example oxalyl chloride optionally in the presence of an inert organic liquid for example dichloromethane and optionally in the presence of a catalytic amount of DMF at a temperature in the range of 0°C to 200°C.

Compounds of formula VIII may be prepared by reacting a compound of formula XI



XI

in which R^2 is as previously defined with a halogenating agent for example thionyl chloride optionally in the presence of an inert organic liquid for example dichloromethane and optionally in the presence of a base for example pyridine at a temperature in the range of 0°C to 200°C.

Compounds of formula IX, X, XI, and XII are commercially available or may be prepared by methods known to those skilled in the art.

Certyain compounds of formula V are useful intermediates in the preparation of compounds of formula I and are believed to be novel. Compounds of formula V are herein claimed as a further aspect of the present invention. The compounds of the invention may be isolated from their reaction mixtures using conventional techniques.

Persons skilled in the art will appreciate that, in order to obtain compounds of the invention in an alternative and in some occasions, more convenient manner, the individual process steps mentioned hereinbefore may be performed in different order, and/or the individual reactions may be performed at different stage in the overall route (i.e. chemical transformations may be performed upon different intermediates to those associated hereinbefore with a particular reaction).

The expression "inert organic liquid" refers to a liquid that does not react with the starting materials, reagents, intermediates or products in a manner that adversely affects the yield of the desired product.

Pharmaceutical preparations

The compounds of the invention will normally be administered via the oral, parenteral, intravenous, intramuscular, subcutaneous or in other injectable ways, buccal, rectal, vaginal, transdermal and/or nasal route and/or via inhalation, in the form of pharmaceutical preparations comprising the active ingredient or a pharmaceutically acceptable salt thereof, in a pharmaceutically acceptable dosage form. Depending upon the disorder and patient to be treated and the route of administration, the compositions may be administered at varying doses.

Suitable daily doses of the compounds of the invention in therapeutical treatment of humans are about 0.0001-100 mg/kg body weight, preferably 0.001-10 mg/kg body weight.

Oral formulations are preferred particularly tablets or capsules which may be formulated by methods known to those skilled in the art to provide doses of the active compound in the range of 0.5mg to 500mg for example 1 mg, 3 mg, 5 mg, 10 mg, 25mg, 50mg, 100mg and 250mg.

According to a further aspect of the invention there is thus provided a pharmaceutical formulation including any of the compounds of the invention, or pharmaceutically acceptable derivatives thereof, in admixture with pharmaceutically acceptable adjuvants, diluents and/or carriers.

Pharmacological properties

The compounds of formula (I) are useful for normalization of cholesterol homeostasis, decreasing intestinal cholesterol, decreasing cholesterol absorption, improving reverse cholesterol transport, improving HDL functionality, increasing HDL levels, decreasing cholesterol content of apoB-containing lipoproteins, stimulating cholesterol secretion from vascular cells and/or decreasing the inflammatory response of vascular cells. As a consequence of these properties the compounds of formula I are expected to have anti-atherosclerotic effects.

The present compounds of formula (I) are also useful for the prophylaxis and/or treatment of clinical conditions associated with inherent or induced reduced sensitivity to insulin (insulin resistance) and associated metabolic disorders (also known as metabolic syndrome). These clinical conditions will include, but will not be limited to, general obesity, abdominal obesity, arterial hypertension, hyperinsulinaemia, hyperglycaemia, type 2 diabetes and the dyslipidaemia characteristically appearing with insulin resistance. This dyslipidaemia, also known as the atherogenic lipoprotein profile, is characterised by moderately elevated non-esterified fatty acids, elevated very low density lipoprotein (VLDL) triglyceride rich particles, high Apo B levels, low high density lipoprotein (HDL) levels associated with low apoAI levels in the presence of small, dense, low density lipoproteins (LDL) particles, phenotype B.

The compounds of the present invention are expected to be useful in treating patients with combined or mixed hyperlipidemias, especially low HDL levels with or without other manifestations of the metabolic syndrome.

Treatment with the present compounds is expected to lower the cardiovascular morbidity and mortality associated with atherosclerosis due to their antidyslipidaemic as well as antiinflammatory properties. The cardiovascular disease conditions include macro-angiopathies of various internal organs causing myocardial infarction, congestive heart failure, cerebrovascular disease and peripheral arterial insufficiency of the lower extremities. Because of their insulin sensitizing effect the compounds of formula I are also expected to prevent or delay the development of type 2 diabetes from the metabolic syndrome and diabetes of pregnancy. Therefore the development of long-term complications associated with chronic hyperglycaemia in diabetes mellitus such as the micro-angiopathies causing renal disease, retinal damage and peripheral vascular disease of the lower limbs are expected to be delayed. Furthermore the compounds may be useful in treatment of various conditions outside the cardiovascular system whether or not associated with insulin resistance, like polycystic ovarian syndrome, obesity, cancer and states of inflammatory disease including neurodegenerative disorders such as mild cognitive impairment, Alzheimer´s disease, Parkinson´s disease and multiple sclerosis.

The compounds of the present invention are expected to be useful in controlling glucose levels in patients suffering from type 2 diabetes.

The present invention provides a method of treating or preventing dyslipidemias, the insulin resistance syndrome and/or metabolic disorders (as defined above) comprising the administration of a compound of formula I to a mammal (particularly a human) in need thereof.

The present invention provides a method of treating or preventing type 2 diabetes comprising the administration of an effective amount of a compound of formula I to a mammal (particularly a human) in need thereof.

In a further aspect the present invention provides the use of a compound of formula I as a medicament.

In a further aspect the present invention provides the use of a compound of formula I in the manufacture of a medicament for the treatment of insulin resistance and/or metabolic disorders.

Combination Therapy

The compounds of the invention may be combined with another therapeutic agent that is useful in the treatment of disorders associated with the development and progress of atherosclerosis such as hypertension, hyperlipidaemias, dyslipidaemias, diabetes and obesity. The compounds of the invention may be combined with another therapeutic agent that decreases the ratio of LDL:HDL or an agent that causes a decrease in circulating levels of LDL-cholesterol. In patients with diabetes mellitus the compounds of the invention may also be combined with therapeutic agents used to treat complications related to micro-angiopathies.

The compounds of the invention may be used alongside other therapies for the treatment of metabolic syndrome or type 2 diabetes and its associated complications, these include biguanide drugs, for example metformin, phenformin and buformin, insulin (synthetic insulin analogues, amylin) and oral antihyperglycemics (these are divided into prandial glucose regulators and alpha-glucosidase inhibitors). An example of an alpha-glucosidase inhibitor is acarbose or voglibose or miglitol. An example of a prandial glucose regulator is repaglinide or nateglinide.

In another aspect of the invention, the compound of formula I, or a pharmaceutically acceptable salt thereof, may be administered in association with a PPAR modulating agent. PPAR modulating agents include but are not limited to a PPAR alpha and/or gamma and/or delta agonist, or pharmaceutically acceptable salts, solvates, solvates of such salts or prodrugs thereof. Suitable PPAR alpha and/or gamma agonists, pharmaceutically acceptable salts, solvates, solvates of such salts or prodrugs thereof are well known in the art. These include the compounds described in WO 01/12187, WO 01/12612, WO 99/62870, WO 99/62872, WO 99/62871, WO 98/57941, WO 01/40170, J Med Chem, 1996, 39, 665, Expert Opinion on Therapeutic Patents, 10 (5), 623-634 (in particular the compounds described in the patent applications listed on page 634) and J Med Chem,

2000, 43, 527 which are all incorporated herein by reference. Particularly a PPAR alpha and/or gamma agonist refers to BMS 298585, clofibrate, fenofibrate, bezafibrate, gemfibrozil and ciprofibrate; pioglitazone, rosiglitazone, MK-767, GW 7845, GW 0207, L-796449, L-165041, LY-818 and LY-929. Particularly a PPAR alpha and/or gamma agonist refers to (S)-2-ethoxy-3-[4-(2-{4-methanesulphonyl-oxyphenyl}ethoxy)phenyl]propanoic acid and pharmaceutically acceptable salts thereof.

In addition the combination of the invention may be used in conjunction with a sulfonylurea for example: glimepiride, glibenclamide (glyburide), gliclazide, glipizide, gliquidone, chloropropamide, tolbutamide, acetohexamide, glycopyramide, carbutamide, glibonuride, glisoxepid, glybuthiazole, glibuzole, glyhexamide, glymidine, glypinamide, phenbutamide, tolcylamide and tolazamide. Preferably the sulfonylurea is glimepiride or glibenclamide (glyburide). More preferably the sulfonylurea is glimepiride. Therefore the present invention includes administration of a compound of the present invention in conjunction with one, two or more existing therapies described in this paragraph. The doses of the other existing therapies for the treatment of type 2 diabetes and its associated complications will be those known in the art and approved for use by regulatory bodies for example the FDA and may be found in the Orange Book published by the FDA. Alternatively smaller doses may be used as a result of the benefits derived from the combination. The present invention also includes a compound of the present invention in combination with a cholesterol-lowering agent. The cholesterol-lowering agents referred to in this application include but are not limited to inhibitors of HMG-CoA reductase (3-hydroxy-3-methylglutaryl coenzyme A reductase). Suitably the HMG-CoA reductase inhibitor is a statin selected from the group consisting of atorvastatin, fluvastatin, itavastatin, lovastatin, mevastatin, nicostatin, nivastatin, pravastatin and simvastatin, or a pharmaceutically acceptable salt, especially sodium or calcium, or a solvate thereof, or a solvate of such a salt. A particular statin is atorvastatin, or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof. A more particular statin is atorvastatin calcium salt. A particularly preferred statin is, however, a compound with the chemical name (E)-7-[4-(4-fluorophenyl)-6-isopropyl-2-[methyl(methylsulfonyl)-amino]-pyrimidin-5-yl](3R,5S)-3,5-dihydroxyhept-6-enoic acid, or a pharmaceutically acceptable salt or solvate thereof, or a solvate of such a salt. The compound (E)-7-[4-(4-

fluorophenyl)-6-isopropyl-2-[methyl-(methylsulfonyl)-amino]-pyrimidin-5-yl](3R,5S)-3,5-dihydroxyhept-6-enoic acid, and its calcium and sodium salts are disclosed in European Patent Application, Publication No. EP-A-0521471, and in Bioorganic and Medicinal Chemistry, (1997), 5(2), 437-444. This latter statin is now known under its generic name rosuvastatin.

In the present application, the term "cholesterol-lowering agent" also includes chemical modifications of the HMG-CoA reductase inhibitors, such as esters, prodrugs and metabolites, whether active or inactive.

The present invention also includes a compound of the present invention in combination with an inhibitor of the ileal bile acid transport system (IBAT inhibitor).

Suitable compounds possessing IBAT inhibitory activity have been described, see for instance the compounds described in WO 93/16055, WO 94/18183, WO 94/18184, WO 96/05188, WO 96/08484, WO 96/16051, WO 97/33882, WO 98/07449, WO 98/03818, WO 98/38182, WO 99/32478, WO 99/35135, WO 98/40375, WO 99/35153, WO 99/64409, WO 99/64410, WO 00/01687, WO 00/47568, WO 00/61568, WO 00/62810, WO 01/68906, DE 19825804, WO 00/38725, WO 00/38726, WO 00/38727, WO 00/38728, WO 00/38729, WO 01/68906, WO 01/66533, WO 02/32428, WO 02/50051, EP 864 582, EP489423, EP549967, EP573848, EP624593, EP624594, EP624595 and EP624596 and the contents of these patent applications are incorporated herein by reference.

Particular classes of IBAT inhibitors suitable for use in the present invention are benzothiepines, and the compounds described in the claims, particularly claim 1, of WO 00/01687, WO 96/08484 and WO 97/33882 are incorporated herein by reference. Other suitable classes of IBAT inhibitors are the 1,2-benzothiazepines, 1,4-benzothiazepines and 1,5-benzothiazepines. A further suitable class of IBAT inhibitors is the 1,2,5-benzothiadiazepines.

One particular suitable compound possessing IBAT inhibitory activity is (3*R*,5*R*)-3-butyl-3-ethyl-1,1-dioxido-5-phenyl-2,3,4,5-tetrahydro-1,4-benzothiazepin-8-yl β-D-glucopyranosiduronic acid (EP 864 582). Other suitable IBAT inhibitors include one of:

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-1'-phenyl-1'-[*N'*-(carboxymethyl) carbamoyl]methyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(carboxymethyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-1'-phenyl-1'-[*N'*-(2-sulphoethyl)carbamoyl]methyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-(*N*-{(R)-1'-phenyl-1'-[*N'*-(2-sulphoethyl)carbamoyl]methyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(2-sulphoethyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(2-sulphoethyl) carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(2-carboxyethyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(2-carboxyethyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(5-carboxypentyl) carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(2-carboxyethyl)carbamoyl] benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{α-[*N'*-(2-sulphoethyl)carbamoyl]-2-fluorobenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(R)-(2-hydroxy-1-carboxyethyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(R)-(2-hydroxy-1-carboxyethyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-{*N*-[(R)-α-(*N'*-{(R)-1-[*N''*-(R)-(2-hydroxy-1-carboxyethyl)carbamoyl]-2-hydroxyethyl}carbamoyl)benzyl]carbamoylmethoxy}-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-(*N*-{α-[*N'*-(carboxymethyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-(*N*-{α-[*N'*-((ethoxy)(methyl)phosphoryl-methyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3-butyl-3-ethyl-5-phenyl-7-methylthio-8-{*N*-[(R)-α-(*N'*-{2-[(hydroxy)(methyl)phosphoryl]ethyl}carbamoyl)benzyl]carbamoylmethoxy}-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N'*-(2-methylthio-1-carboxyethyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-{*N*-[(R)-α-(*N'*-{2-[(methyl)(ethyl)phosphoryl]ethyl}carbamoyl)-4-hydroxybenzyl]carbamoylmethoxy}-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-{*N*-[(R)-α-(*N'*-{2-[(methyl)(hydroxy)phosphoryl]ethyl}carbamoyl)-4-hydroxybenzyl]carbamoylmethoxy}-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[(R)-*N'*-(2-methylsulphinyl-1-carboxyethyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methoxy-8-[*N*-{(R)-α-[*N'*-(2-sulphoethyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy]-2,3,4,5-tetrahydro-1,5-benzothiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((R)-1-carboxy-2-methylthio-ethyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxy-2-(R)-hydroxypropyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxy-2-methylpropyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxybutyl) carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxypropyl) carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxyethyl) carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxy-2-(R)-hydroxypropyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-(2-sulphoethyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxyethyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((R)-1-carboxy-2-methylthioethyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-{(S)-1-[*N*-((S)-2-hydroxy-1-carboxyethyl)carbamoyl]propyl}carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxy-2-methylpropyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-Dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-((S)-1-carboxypropyl) carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-Dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-[*N*-((R/S)-α-{*N*-[1-(R)-2-(S)-1-hydroxy-1-(3,4-dihydroxyphenyl)prop-2-yl]carbamoyl}-4-hydroxybenzyl)carbamoylmethoxy]-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

1,1-Dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-(2-(S)-3-(R)-4-(R)-5-(R)-2,3,4,5,6-pentahydroxyhexyl)carbamoyl]-4-hydroxybenzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine; and

1,1-Dioxo-3,3-dibutyl-5-phenyl-7-methylthio-8-(*N*-{(R)-α-[*N*-(2-(S)-3-(R)-4-(R)-5-(R)-2,3,4,5,6-pentahydroxyhexyl)carbamoyl]benzyl}carbamoylmethoxy)-2,3,4,5-tetrahydro-1,2,5-benzothiadiazepine;

or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof.

According to an additional further aspect of the present invention there is provided a combination treatment comprising the administration of an effective amount of a compound of the formula I, or a pharmaceutically acceptable salt thereof, optionally together with a pharmaceutically acceptable diluent or carrier, with the simultaneous, sequential or separate administration one or more of the following agents selected from:

a CETP (cholesteryl ester transfer protein) inhibitor, for example those referenced and described in WO 00/38725 page 7 line 22 - page 10, line 17 which are incorporated herein by reference;

a cholesterol absorption antagonist for example azetidinones such as SCH 58235 and those described in US 5,767,115 which are incorporated herein by reference;

a MTP (microsomal transfer protein) inhibitor for example those described in Science, 282, 751-54, 1998 which are incorporated herein by reference;

a nicotinic acid derivative, including slow release and combination products, for example, nicotinic acid (niacin), acipimox and niceritrol;

a phytosterol compound for example stanols;

probucol;

an anti-obesity compound for example a pancreatic lipase inhibitor e.g. orlistat (EP 129,748) or an appetite (satiety) controlling substance for example sibutramine (GB 2,184,122 and US 4,929,629);

an antihypertensive compound for example an angiotensin converting enzyme (ACE) inhibitor, an angiotensin II receptor antagonist, an andrenergic blocker, an alpha andrenergic blocker, a beta andrenergic blocker, a mixed alpha/beta andrenergic blocker, an andrenergic stimulant, calcium channel blocker, an AT-1 blocker, a saluretic, a diuretic or a vasodilator;

a CB1 antagonist or inverse agonist for example as described in WO01/70700 and EP 65635 ;

a Melanin concentrating hormone (MCH) antagonist;

a PDK inhibitor; or

modulators of nuclear receptors for example FXR, RXR, and RORalpha;

or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof, optionally together with a pharmaceutically acceptable diluent or carrier to a warm-blooded animal, such as man in need of such therapeutic treatment.

Particular ACE inhibitors or pharmaceutically acceptable salts, solvates, solvate of such salts or prodrugs thereof, including active metabolites, which can be used in combination with a compound of formula I include but are not limited to, the following compounds: alacepril, alatriopril, altiopril calcium, ancovenin, benazepril, benazepril hydrochloride, benazeprilat, benzoylcaptopril, captopril, captopril-cysteine, captopril-glutathione, ceranapril, ceranopril, ceronapril, cilazapril, cilazaprilat, delapril, delapril-diacid, enalapril, enalaprilat, enapril, epicaptopril, foroxymithine, fosfenopril, fosenopril, fosenopril sodium, fosinopril, fosinopril sodium, fosinoprilat, fosinoprilic acid, glycopril, hemorphin-4, idrapril, imidapril, indolapril, indolaprilat, libenzapril, lisinopril, lyciumin A, lyciumin B, mixanpril, moexipril, moexiprilat, moveltipril, muracein A, muracein B, muracein C, pentopril, perindopril, perindoprilat, pivalopril, pivopril, quinapril, quinapril hydrochloride, quinaprilat, ramipril, ramiprilat, spirapril, spirapril hydrochloride, spiraprilat, spiropril, spiropril hydrochloride, temocapril, temocapril hydrochloride, teprotide, trandolapril, trandolaprilat, utibapril, zabicipril, zabiciprilat, zofenopril and zofenoprilat. Preferred ACE

inhibitors for use in the present invention are ramipril, ramiprilat, lisinopril, enalapril and enalaprilat. More preferred ACE inhibitors for uses in the present invention are ramipril and ramiprilat.

Preferred angiotensin II antagonists, pharmaceutically acceptable salts, solvates, solvate of such salts or a prodrugs thereof for use in combination with a compound of formula I include, but are not limited to, compounds: candesartan, candesartan cilexetil, losartan, valsartan, irbesartan, tasosartan, telmisartan and eprosartan. Particularly preferred angiotensin II antagonists or pharmaceutically acceptable derivatives thereof for use in the present invention are candesartan and candesartan cilexetil.

Therefore in an additional feature of the invention, there is provided a method for the treatment of type 2 diabetes and its associated complications in a warm-blooded animal, such as man, in need of such treatment which comprises administering to said animal an effective amount of a compound of formula I, or a pharmaceutically acceptable salt thereof in simultaneous, sequential or separate administration with an effective amount of one of the other compounds described in this combination section, or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof.

Therefore in an additional feature of the invention, there is provided a method of treating hyperlipidemic conditions in a warm-blooded animal, such as man, in need of such treatment which comprises administering to said animal an effective amount of a compound of formula I, or a pharmaceutically acceptable salt thereof in simultaneous, sequential or separate administration with an effective amount of one of the other compounds described in this combination section or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof.

According to a further aspect of the invention there is provided a pharmaceutical composition which comprises a compound of formula I, or a pharmaceutically acceptable salt thereof, and one of the other compounds described in this combination section or a

pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof, in association with a pharmaceutically acceptable diluent or carrier.

According to a further aspect of the present invention there is provided a kit comprising a compound of formula I, or a pharmaceutically acceptable salt thereof, and one of the other compounds described in this combination section or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof.

According to a further aspect of the present invention there is provided a kit comprising:

a) a compound of formula I, or a pharmaceutically acceptable salt thereof, in a first unit dosage form;

b) one of the other compounds described in this combination section or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof; in a second unit dosage form; and

c) container means for containing said first and second dosage forms.

According to a further aspect of the present invention there is provided a kit comprising:

a) a compound of formula I, or a pharmaceutically acceptable salt thereof, together with a pharmaceutically acceptable diluent or carrier, in a first unit dosage form;

b) one of the other compounds described in this combination section or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof, in a second unit dosage form; and

c) container means for containing said first and second dosage forms.

According to another feature of the invention there is provided the use of a compound of the formula I, or a pharmaceutically acceptable salt thereof, and one of the other compounds described in this combination section, or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof, in the manufacture of a medicament for use in the the treatment of metabolic syndrome or type 2 diabetes and its associated complications in a warm-blooded animal, such as man.

According to another feature of the invention there is provided the use of a compound of the formula I, or a pharmaceutically acceptable salt thereof, and one of the other compounds described in this combination section, or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof, in the manufacture of a medicament for use in the treatment of hyperlipidaemic conditions in a warm-blooded animal, such as man.

According to a further aspect of the present invention there is provided a combination treatment comprising the administration of an effective amount of a compound of the formula I, or a pharmaceutically acceptable salt thereof, optionally together with a pharmaceutically acceptable diluent or carrier, with the simultaneous, sequential or separate administration of an effective amount of one of the other compounds described in this combination section, or a pharmaceutically acceptable salt, solvate, solvate of such a salt or a prodrug thereof, optionally together with a pharmaceutically acceptable diluent or carrier to a warm-blooded animal, such as man in need of such therapeutic treatment.

Examples

Abbreviations

DMF	*N, N*-dimethylformamide
DMSO	dimethylsulfoxide
EtOAc	ethyl acetate
EtOH	ethanol
HPLC	high performance liquid chromatography
NMR	nuclear magnetic resonance
THF	tetrahydrofuran
UV	ultra violet
rt	room temperature
br	broad
bs	broad singlet
bt	broad triplet
d	doublet
dd	doublet of doublets
m	multiplet

q	quartet
s	singlet
t	triplet

General Experimental Procedures

Flash column chromatography employed normal phase silica gel 60 (0.040-0.063 mm, Merck) or IST Isolute®SPE columns normal phase silica gel. Purifications were performed on either a Gilson preparative HPLC system with a UV triggered fraction collector, equipped with a ACE C8 5 µm 250 mm x 20 mm column, or on a Waters preparative HPLC system equipped with an ACE C8 5 µm 250 mm x 50 mm column or an ACE C8 5 µm 250 mm x 20 mm column. ^{1}H NMR spectra were obtained on a Varian Unity Plus, 400 MHz, operating at 9.3 T, equipped with a 5 mm switchable probe with an inner X-coil, for solutions in CDCl3 (residual $CHCl_3$ (δ_H 7.23 ppm) as internal standard), or DMSO-d_6 (residual DMSO (δ_H 2.50 ppm) as internal standard) at 300K. Chemical shifts are given in ppm. Microwave heating was performed using single node heating in a Smith Creator from Personal Chemistry, Uppsala, Sweden. Lawesson´s reagent is 2,4-Bis(4-methoxyphenyl)-1,3,2,4-dithiadiphosphetane-2,4-disulfide.

Synthesis of Starting Materials and Intermediates

3-Chloro-4-phenylfuran-2,5-dione

To an ice cold solution of phenylmaleic anhydride (5.74 mmol, 1.0g) in thionyl chloride (6.0 mL) was added dropwise pyridine (11.4 mmol, 0.9g). The reaction mixture was stirred for 60 min at 0°C, followed by heating to 75°C for 20 min. The reaction mixture was cooled to room temperature and the thionyl chloride was removed *in vacuo*. The crude residue was suspended in toluene (10 mL), refluxed for 10 min., followed by filtration of the hot mixture. The filtrate was concentrated to give 1.15g (96%) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05-8.00 (m, 2H), 7.59 - 7.51 (m, 3H).

3-Chloro-1-(2-methoxyethyl)-4-phenyl-1H-pyrrole-2,5-dione

A solution of 3-chloro-4-phenylfuran-2,5-dione (0.20 mmol, 42 mg) and 2-methoxyethylamine (0.20 mmol, 15 mg) in glacial acetic acid (1 mL) was heated in a

microwave reactor at 120 °C for two minutes. After cooling, the solvent was evaporated at reduced pressure. The crude product was used without purification.

1-(2-Methoxyethyl)-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione

3-Chloro-1-(2-methoxyethyl)-4-phenyl-1H-pyrrole-2,5-dione (0.20 mmol, 53 mg) and 4-methoxyaniline (0.48 mmol, 59 mg) were dissolved in DMF (1 mL). The mixture was heated in a microwave reactor at 150 °C for five minutes. After cooling, the reaction mixture was purified by HPLC (95% 0.1M ammonium acetate buffer: 5% $CH_3CN \rightarrow$ 100% CH_3CN) to give 15 mg (21 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.27 (bs, 1H), 7.13-7.04 (m, 3H), 7.00-6.96 (m, 2H), 6.61-6.50 (m, 4H), 3.80 (t, J=5.6 Hz, 2H), 3.67 (s, 3H), 3.62 (t, J=5.6 Hz, 2H), 3.36 (s, 3H).

3-Chloro-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dione

A solution of 3-chloro-4-phenylfuran-2,5-dione (1.00 mmol, 209 mg) and 3-(aminomethyl)-pyridine (1.00 mmol, 26 mg) in glacial acetic acid (4 mL) was heated in a microwave reactor at 120 °C for two minutes. After cooling, the solvent was evaporated at reduced pressure. The crude product was used without purification.

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dione.

To a solution of 3-chloro-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dione (0.50 mmol, 149 mg) in DMF (1 mL) was added 4-methoxyaniline (1.10 mmol, 135 mg) The mixture was heated in a microwave reactor at 150 °C for 5 minutes. After cooling, the reaction mixture was purified by HPLC (95% 0.1M ammonium acetate buffer: 5% $CH_3CN \rightarrow$ 100% CH_3CN) to give 77 mg (40 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 8.71 (d, J=1.8 Hz, 1H), 8.54 (dd, J_1=4.7 Hz, J_2=1.6 Hz, 1H), 7.80-7.75 (m, 1H), 7.35 (bs, 1H), 7.26 (dd, J_1=7.8 Hz, J_2=4.7 Hz, 1H), 7.15-7.05 (m, 3H), 6.98-6.94 (m, 2H), 6.62-6.50 (m, 4H), 4.78 (s, 2H), 3.68 (s, 3H).

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-4-ylmethyl)-1H-pyrrole-2,5-dione

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.500 mmol, 147 mg), 4-hydroxymethylpyridine (0.750 mmol, 82 mg), diethyl azodicarboxylate (0.750 mmol, 131 mg) and triphenylphosphine (0.750 mmol, 197 mg) in dry THF (2 mL) was

heated in a microwave reactor at 120 °C for 5 minutes. After cooling, the reaction mixture was purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 56 mg (29 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 8.59 (bs, 2H), 7.35-7.29 (m, br, 2H), 7.25 (s, br, 1H), 7.17-7.06 (m, 3H), 7.01-6.96 (m, 2H), 6.63-6.53 (m, 4H), 4.77 (s, 2H), 3.70 (s, 3H).

1-Butyl-3-chloro-4-pheny l-1*H*-pyrrole-2,5-dione

To a solution of 3-Chloro-4-phenylfuran-2,5-dion (24.0 mmol, 5.0g) in glacial acetic acid (60 mL) was added dropwise butylamine (24.0 mmol, 1.75g) over a period of 10 min. and the reaction mixture was boiled under refluxed for 60 min. The reaction mixture was concentrated and partitioned between water and EtOAc and the organic layer was dried over anhydrous Na_2SO_4. After removal of the solvent, the residual oil was purified using pre-packed SiO_2 column (2x70g) eluted with heptane (300 mL); heptane:EtOAc (95:5, 450 mL), and finally heptane:EtOAc (9:1, 450 mL) to give 2.67g (42%) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.96-7.90 (m, 2H) 7.51-7.45 (m, 3H), 3.63 (t, J=7.2 Hz, 2H), 1.68-1.58 (m, 2H) 1.41-1.30 (m, 2H), 0.95 (t, J=7.3 Hz, 3H).

1-Butyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dione

To a solution of 1-Butyl-3-chloro-4-pheny l-1*H*-pyrrole-2,5-dione (10.1 mmol, 2.7g) in absolute EtOH (30 mL) was added p-methoxyaniline (20.2 mmol, 2.49g) in one portion and the mixture was refluxed for 4 h. The mixture was cooled to room temperature, the precipitate filtered off and washed with several portions of ice-cooled EtOH, and the solid product was finally dried over $CaCl_2$ to give 2.37 g (80%) of the title compound. ^1H NMR (400 MHz, CDCl3) δ 7.18 (bs, 1H), 7.13-7.05 (m, 3H), 7.01-6.96 (m, 2H), 6.62-6.52 (m, 4H), 3.69 (s, 3H), 3.61 (t, J=7.2 Hz, 2H), 1.71-1.60 (m, 2H), 1.44-1.32 (m, 2H), 0.95 (t, J=7.3 Hz, 3H).

3-Hydroxy-4-phenyl-1*H*-pyrrole-2,5-dione

Prepared according to literature procedure: C. S. Rooney, et al; J. Med. Chem., Vol. 26 (1983) pp 700-714.

3-Chloro-4-phenyl-1*H*-pyrrole-2,5-dione

To a suspension of 3-hydroxy-4-phenyl-1*H*-pyrrole-2,5-dione (25.0 g, 0.13 mol) in dichloromethane (600 ml) under an atmosphere of nitrogen was added DMF (36 ml). The suspension was cooled to ice temperature and treated with oxalyl chloride (40.0 g, 0.32 mol). The reaction mixture was subsequently refluxed overnight. After cooling to room temperature silica gel was added and the reaction mixture evaporated to dryness and subjected to flash chromatography (hexane:EtOAc 80:20). Trituration with dichloromethane, filtration and drying gave 17.6 g (64%) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96-7.89 (m, 2H), 7.88-7.77 (bs, 1H), 7.55-7.45 (m, 3H).

3-[(4-methoxyphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dione

To a solution of 3-Chloro-4-phenyl-1*H*-pyrrole-2,5-dione (4.84 mmol, 1.0 g) in dry DMF (5 mL) was added 4-methoxyaniline (4.87 mmol, 600 mg) and the reaction mixture was subjected to microwave heating single node 150°C, 15 min, followed by 150°C, 10 min. The solvent was evaporated, and the crude mixture was partitioned between dichloromethane and water. The organic phase was dried over anhydrous Na_2SO_4, concentrated and the residue was purified on SiO_2 (Heptane:EtOAc 3:1 → 2:1) to give 457 mg (32%) of the title compound. ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.62 (s, 1H), 9.27 (s, 1H), 7.09-6.99 (m, 3H), 6.87-6.83 (m, 2H), 6.65-6.60 (m, 2H), 6.52-6.47 (m, 2H) 3.58 (s, 3H).

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(2,2,2-trifluoroethyl)-1H-pyrrole-2,5-dione

A solution of 3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (2.11 mmol, 620 mg), diethyl azodicarboxylate (2.11 mmol, 367 mg) and triphenylphosphine (2.11 mmol, 553 mg) in dry THF (2 mL) was prepared in a sealed reaction vessel. 2,2,2-trifluoroethanol (2.11 mmol, 211 mg) was added. The mixture was stirred at 40 °C for 19 hours. Acetonitrile was added until some triphenylphosphine oxide was precipitated. The reaction mixture was filtered and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 260 mg (33 %) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (bs, 1H), 7.18-7.06 (m, 3H), 7.01-6.96 (m, 2H), 6.64-6.52 (m, 4H), 4.23 (q, J=8.8 Hz, 2H), 3.70 (s, 3H).

1-Benzyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.170 mmol, 50 mg), 3-benzylalcohol (0.170 mmol, 18 mg), diethyl azodicarboxylate (0.170 mmol, 30 mg) and triphenylphosphine (0.170 mmol, 45 mg) in dry THF (1 mL) was heated in a microwave reactor at 150 °C for 6 minutes. After cooling, the reaction mixture was purified by HPLC (95% 0.1M ammonium acetate buffer: 5% $CH_3CN \rightarrow$ 100% CH_3CN) to give 32 mg (49 %) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.42 (m, 2H), 7.39-7.27 (m, 3H), 7.17 (bs, 1H), 7.14-7.05 (m, 3H), 7.00-6.96 (m, 2H), 6.61-6.51 (m, 4H), 4.77 (s, 2H), 3.69 (s, 3H

3-[(4-Methoxyphenyl)amino]-1-methyl-4-phenyl-1H-pyrrole-2,5-dione

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.170 mmol, 50 mg), methanol (0.170 mmol, 5 mg), diethyl azodicarboxylate (0.170 mmol, 30 mg) and triphenylphosphine (0.170 mmol, 45 mg) in dry THF (1 mL) was heated in a microwave reactor at 150 °C for 6 minutes. After cooling, the reaction mixture was purified by HPLC (95% 0.1M ammonium acetate buffer: 5% $CH_3CN \rightarrow$ 100% CH_3CN) to give 34 mg (65 %) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 (s, br, 1H), 7.16-7.05 (m, 3H), 7.00-6.96 (m, 2H), 6.62-6.52 (m, 4H), 3.69 (s, 3H), 3.12 (s, 3H).

3-Chloro-1-ethyl-4-phenyl-1H-pyrrole-2,5-dione

A mixture of 3-chloro-4-phenyl-1H-pyrrole-2,5-dione (3.00 mmol, 623 mg), ethyl iodide (3.30 mmol, 515 mg) and potassium carbonate (3.30 mmol, 456 mg) in acetonitrile (10 mL) was refluxed for 3.5 hours. The mixture was evaporated to dryness. The residue was taken up in ethyl acetate, washed with 1 M potassium carbonate solution and brine. Drying with sodium sulfate and evaporation under reduced pressure gave 587 mg (83 %) of the desired product. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97-7.89 (m, 2H), 7.51-7.45 (m, 3H), 3.68 (q, J=7.1 Hz, 2H), 1.25 (t, J=7.1 Hz, 3H).

1-Ethyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione

3-Chloro-1-ethyl-4-phenyl-1H-pyrrole-2,5-dione (1.34 mmol, 315 mg) and 4-methoxyaniline (1.47 mmol, 181 mg) and triethylamine (147 mmol, 149 mg) were dissolved in acetonitrile (4 mL). The mixture was heated in a microwave reactor at 150 °C until complete reaction. After cooling, the reaction mixture was concentrated and filtrated.

Purification by HPLC (95% 0.1M ammonium acetate buffer: 5% $CH_3CN \rightarrow$ 100% CH_3CN) gave 310 mg (72 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.21 (bs, 1H), 7.15-7.06 (m, 3H), 7.01-6.97 (m, 2H), 6.63-6.55 (m, 4H), 3.69 (s, 3H), 3.67 (q, J=7.2 Hz, 2H), 1.27 (t, J=7.2 Hz, 3H).

tert-butyl [5-(bromomethyl)pyridin-2-yl]carbamate

Prepared according to literature procedure: WO0066557 Linschoten, M. et al, Astrazeneca AB, Nov. 9, 2000.

tert-Butyl {5-[(3-chloro-2,5-dioxo-4-phenyl-2,5-dihydro-1_H_-pyrrol-1-yl)methyl]pyridin-2-yl}carbamate

3-Chloro-4-phenyl-1_H_-pyrrole-2,5-dione (1.550 g, 7.466 mmol) was dissolved in DMF (25 ml) under nitrogen atmosphere. It was cooled in an ice-bath. _tert_-Butyl [5-(bromomethyl)pyridin-2-yl]carbamate (2.144 g, 7.466 mmol) was added and then anhydrous potassium carbonate (1.032 g, 7.466 mmol) was added. The mixture was stirred for 1.5 hours and the cooling-bath was removed. The mixture was stirred for 2 hours more and then neutralized with 1% HCl. More water (100 ml) was added and the mixture was extracted with CH_2Cl_2 (50 ml x3). The extracts were combined, washed with water (100 ml x2), dried with magnesium sulphate and evaporated. The crude product (3.41g) was left. It was used in the next steps without further purification. ^1H NMR (400 MHz, $CDCl_3$) δ 8.32 (d, J=2 Hz, 1H), 7.92-7.89 (m, 3H), 7.83 (bs, 1H), 7.72 (dd, J =9, 2 Hz, 1H), 7.49-7.47 (m, 3H), 4.71 (s, 2H) and 1.52 (s, 9H).

1-[(6-Aminopyridin-3-yl)methyl]-3-{[4-(difluoromethoxy)phenyl]amino}-4-phenyl-1_H_-pyrrole-2,5-dione

tert-Butyl {5-[(3-chloro-2,5-dioxo-4-phenyl-2,5-dihydro-1_H_-pyrrol-1-yl)methyl]pyridin-2-yl}carbamate (0.704 g, 1.7 mmol) and 4-(difluoromethoxy)-aniline (0.541 g, 3.4 mmol) were mixed in DMF (4 ml). The mixture was put in the microwave oven (Smithcreator) at 150 °C for 8 minutes. It was then evaporated to remove DMF. Chromatography of the residue on a column (Isolute® SI, 10g/70 ml), using CH_2Cl_2 and then CH_3OH/ CH_2Cl_2 (1:99, 2:98 and then 5:95) as eluant, gave the title compound (0.4g), yield 54%. ^1H NMR (400 MHz, $CDCl_3$) δ 7.99 (bs, 1H), 7.67-7.62 (m, 2H), 7.14-7.04 (m, 3H), 6.91 (d, J =8 Hz,

2H), 6.78 (d, J=8 Hz, 1H), 6.72 (d, J=9 Hz, 2H), 6.63 (d, J=9 Hz, 2H), 6.33 (t, J=74 Hz, 1H) and 4.60 (s, 2H).

1-[(6-Aminopyridin-3-yl)methyl]-3-[(4-morpholin-4-ylphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dione

tert-Butyl {5-[(3-chloro-2,5-dioxo-4-phenyl-2,5-dihydro-1*H*-pyrrol-1-yl)methyl]pyridin-2-yl}carbamate (0.853 g, 2.06 mmol) and 4-morpholinoaniline (0.735 g, 4.12 mmol) were mixed in DMF (4 ml). The mixture was put in the microwave oven (Smithcreator) at 150 °C for 10 minutes. Preparative HPLC (column C18, 50x250 mm, eluted with a gradient from CH_3CN / 0.1M NH_4OAc (40/60) to CH_3CN (100%)) gave the title compound (0.39 g), yield 42%. ^1H NMR (400 MHz, $CDCl_3$) δ 8.14 (bs, 1H), 7.55 (dd, J= 8, 2 Hz, 1H), 7.28-7.23 (br, 1H), 7.13-7.04 (m, 3H), 6.95 (dd, J = 8, 2 Hz, 2H), 6.57-6.51 (m, 4H), 6.44 (d, J= 8 Hz, 1H), 4.62 (s, 2H), 4.62-4.53 (br, 2H) 3.81-3.79(m, 4H) and 3.01-2.98 (m, 4H).

Examples

Example 1

1-(2-Methoxyethyl)-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one

A mixture of 1-(2-methoxyethyl)-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.071 mmol, 25 mg) and Lawesson´s reagent (0.071 mmol, 29 mg) in toluene (2.5 mL) was heated in a microwave reactor at 140 °C for 15 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 16 mg (61 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.78 (bs, 1H), 7.13-6.96 (m, 5H), 6.65-6.60 (m, 2H), 6.56-6.51 (m, 2H), 4.16 (t, J=5.9, 2H), 3.72 (t, J=5.9, 2H), 3.69 (s, 3H), 3.39 (s, 3H)

Example 2

1-(2-Methoxyethyl)-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione

A mixture of 1-(2-methoxyethyl)-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.071 mmol, 25 mg) and Lawesson´s reagent (0.142 mmol, 58 mg) in toluene (2.5

mL) was heated in a microwave reactor at 180 °C for 60 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 14 mg (37 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.41 (s, br, 1H), 7.13-6.93 (m, 5H), 6.64-6.57 (m, 2H), 6.48-6.42 (m, 2H), 4.58 (t, J=6.2, 2H), 3.75 (t, J=6.2, 2H), 3.67 (s, 3H), 3.40 (s, 3H).

Example 3

4-[(4-Methoxyphenyl)amino]-3-phenyl-1-(pyridin-3-ylmethyl)-5-thioxo-1,5-dihydro-2H-pyrrol-2-one

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dione (0.065 mmol, 25 mg) and Lawesson´s reagent (0.065 mmol, 26 mg) in toluene (2.5 mL) was heated in a microwave reactor at 140 °C for 15 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 19 mg (73 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 8.76 (bs, 1H), 8.53 (d, br, 1H), 7.82-7.78 (m, 1H), 7.75 (bs, 1H), 7.28-7.23 (m, 1H), 7.14-7.03 (m, 3H), 7.00-6.95 (m, 2H), 6.63-6.59 (m, 2H), 6.55-6.50 (m, 2H), 5.13 (s, 2H), 3.68 (s, 3H).

Example 4

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dithione

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dione (0.065 mmol, 25 mg) and Lawesson´s reagent (0.143 mmol, 58 mg) in toluene (2.5 mL) was heated in a microwave reactor at 180 °C for 60 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 23 mg (85 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 8.74 (d, br, 1H), 8.53-8.50 (m, 1H), 7.81-7-76 (m, 1H), 7.41 (s, br, 1H), 7.26-7.22 (m, 1H), 7.13-7.02 (m, 3H), 6.98-6.93 (m, 2H), 6.63-6.57 (m, 2H), 6.48-6.42 (m, 2H), 5.59 (s, 2H), 3.67 (s, 3H).

Example 5

4-[(4-Methoxyphenyl)amino]-3-phenyl-1-(pyridin-4-ylmethyl)-5-thioxo-1,5-dihydro-2H-pyrrol-2-one

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1-(pyridin-4-ylmethyl)-1H-pyrrole-2,5-dione (0.073 mmol, 28 mg) and Lawesson´s reagent (0.073 mmol, 29 mg) in toluene (2.5 mL) was heated in a microwave reactor at 140 °C for 15 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 9 mg (31 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 8.57 (s, br, 2H), 7.76 (s, br, 1H), 7.32 (d, br, 2H), 7.14-7.05 (m, 3H), 7.01-6.97 (m, 2H), 6.65-6.60 (m, 2H), 6.56-6.51 (m, 2H), 5.11 (s, 2H), 3.69 (s, 3H).

Example 6

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-4-ylmethyl)-1H-pyrrole-2,5-dithione

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1-(pyridin-4-ylmethyl)-1H-pyrrole-2,5-dione (0.073 mmol, 28 mg) and Lawesson´s reagent (0.145 mmol, 59 mg) in toluene (2.5 mL) was heated in a microwave reactor at 180 °C for 60 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 4 mg (13 %)

of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (dd, J_1=6.1 Hz, J_2=4.4 Hz, 2H), 7.41 (s, br, 1H), 7.28 (dd, J_1=6.1 Hz, J_2=4.4 Hz, 2H), 7.14-7.03 (m, 3H), 7.00-6.95 (m, 2H), 6.65-6.59 (m, 2H), 6.49-6.43 (m, 2H), 5.58 (s, 2H), 3.67 (s, 3H).

Example 7

1-Butyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one

A mixture of 1-butyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.120 mmol, 42 mg) and Lawesson´s reagent (0.144 mmol, 58 mg) in toluene (1.7 mL) was heated in a microwave reactor at 120 °C for five minutes. The solvent was evaporated at reduced pressure. Purification by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) gave 28 mg (64 %) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (s, br, 1H), 7.12-7.04 (m, 3H), 7.01-6.96 (m, 2H), 6.51-6.46 (m, 4H), 3.94 (t, J=7.5 Hz, 2H), 3.69 (s, 3H), 1.77-1.68 (m, 2H), 1.45-1.35 (m, 2H), 0.96 (t, J=7.3 Hz, 3H).

Example 8

1-Butyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione

A mixture of 1-butyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.120 mmol, 42 mg) and Lawesson´s reagent (0.264 mmol, 107 mg) in toluene was heated in a microwave reactor at 160 °C for 25 minutes. The solvent was evaporated at reduced pressure. Purification by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) gave 28 mg (61 %) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (s, br, 1H), 7.12-7.02 (m, 3H), 6.98-6.93 (m, 2H), 6.63-6.57 (m, 2H), 6.47-6.43 (m, 2H), 4.36-4.30 (m, 2H), 3.68 (s, 3H), 1.80-1.70 (m, 2H), 1.48-1.37 (m, 2H), 0.97 (t, J=7.7 Hz, 3H).

Example 9

4-[(4-Methoxyphenyl)amino]-3-phenyl-5-thioxo-1-(2,2,2-trifluoroethyl)-1,5-dihydro-2H-pyrrol-2-one

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1-(2,2,2-trifluoroethyl)-1H-pyrrole-2,5-dione (0.053 mmol, 20 mg) and Lawesson´s reagent (0.053 mmol, 21 mg) in toluene (2.5 mL) was heated in a microwave reactor at 140 °C for 15 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC

(95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 12 mg (58 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.74 (s, br, 1H), 7.15-7.05 (m, 3H), 7.02-6.97 (m, 2H), 6.67-6.61 (m, 2H), 6.57-6.52 (m, 2H), 4.59 (q, J=8.6 Hz, 2H), 3.69 (s, 3H).

Example 10

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(2,2,2-trifluoroethyl)-1H-pyrrole-2,5-dithione

A mixture of 3-[(4-methoxyphenyl)amino]-4-phenyl-1-(2,2,2-trifluoroethyl)-1H-pyrrole-2,5-dione (0.053 mmol, 20 mg) and Lawesson´s reagent (0.11 mmol, 43 mg) in toluene (2.5 mL) was heated in a microwave reactor at 180 °C for 60 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 11 mg (51 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.40 (s, br, 1H), 7.15-7.02 (m, 3H), 6.99-6.93 (m, 2H), 6.64-6.59 (m, 2H), 6.48-6.43 (m, 2H), 5.08 (q, J=8.4 Hz, 2H), 3.68 (s, 3H).

Example 11

1-Benzyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one

A mixture of 1-benzyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.075 mmol, 29 mg) and Lawesson´s reagent (0.075 mmol, 31 mg) in toluene (2.5 mL) was heated in a microwave reactor at 140 °C for 15 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 15 mg (50 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.77 (s, br, 1H), 7.50-7.46 (m, 2H), 7.36-7.25 (m, 3H), 7.14-7.04 (m, 3H), 7.02-6.97 (m, 2H), 6.64-6.59 (m, 2H), 6.56-6.50 (m, 2H), 5.13 (s, 2H), 3.69 (s, 3H).

Example 12

1-Benzyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione

A mixture of 1-benzyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.075 mmol, 29 mg) and Lawesson´s reagent (0.151 mmol, 61 mg) in toluene (2.5 mL) was heated in a microwave reactor at 180 °C for 60 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 18 mg (57 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.46-7.41 (m, 2H), 7.40 (s, br, 1H), 7.34-7.22 (m, 3H), 7.13-7.02 (m, 3H), 7.00-6.95 (m, 2H), 6.63-6.57 (m, 2H), 6.48-6.42 (m, 2H), 5.59 (s, 2H), 3.67 (s, 3H).

Example 13

4-[(4-Methoxyphenyl)amino]-1-methyl-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one

A mixture of 3-[(4-methoxyphenyl)amino]-1-methyl-4-phenyl-1H-pyrrole-2,5-dione (0.088 mmol, 27 mg) and Lawesson´s reagent (0.088 mmol, 35 mg) in toluene (2.5 mL) was heated in a microwave reactor at 140 °C for 15 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 20 mg (70 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.78 (s, br, 1H), 7.13-7.03 (m, 3H), 7.00-6.96 (m, 2H), 6.64-6.60 (m, 2H), 6.56-6.51 (m, 2H), 3.69 (s, 3H), 3.40 (s, 3H).

Example 14

3-[(4-Methoxyphenyl)amino]-1-methyl-4-phenyl-1*H*-pyrrole-2,5-dithione

A mixture of 3-[(4-methoxyphenyl)amino]-1-methyl-4-phenyl-1H-pyrrole-2,5-dione (0.088 mmol, 27 mg) and Lawesson´s reagent (0.175 mmol, 71 mg) in toluene (2.5 mL) was heated in a microwave reactor at 180 °C for 60 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 26 mg (87 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.41 (s, br, 1H), 7.13-7.02 (m, 3H), 6.99-6.93 (m, 2H), 6.63-6.57 (m, 2H), 6.48-6.42 (m, 2H), 3.74 (s, 3H), 3.67 (s, 3H).

Example 15

1-Ethyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one

A mixture of 1-ethyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.397 mmol, 128 mg) and Lawesson´s reagent (0.397 mmol, 161 mg) in toluene (2.0 mL) was heated in a microwave reactor at 160 °C for 15 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 95 mg (71 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.80 (s, br, 1H), 7.13-7.04 (m, 3H), 7.01-6.97 (m, 2H), 6.65-6.60 (m 2H), 6.56-6.51 (m, 2H), 4.01 (q, J=7.1 Hz, 2H), 3.69 (s, 3H), 1.31 (t, J=7.1 Hz, 3H).

Example 16

1-Ethyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione

A mixture of 1-ethyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dione (0.090 mmol, 29 mg) and Lawesson´s reagent (0.180 mmol, 73 mg) in toluene (2.5 mL) was heated in a microwave reactor at 180 °C for 60 minutes. The solvent was evaporated at reduced pressure. The residue was redissolved in THF and purified by HPLC (95% 0.1M ammonium acetate buffer: 5% CH_3CN → 100% CH_3CN) to give 15 mg (48 %) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 7.42 (s, br, 1H), 7.12-7.02 (m, 3H), 6.98-6.93 (m, 2H), 6.63-6.57 (m 2H), 6.47-6.42 (m, 2H), 4.41 (q, J=7.1 Hz, 2H), 3.67 (s, 3H), 1.31 (t, J=7.1 Hz, 3H).

Example 17

1-[(6-Aminopyridin-3-yl)methyl]-4-{[4-(difluoromethoxy)phenyl]amino}-3-phenyl-5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one

1-[(6-Aminopyridin-3-yl)methyl]-3-{[4-(difluoromethoxy)phenyl]amino}-4-phenyl-1*H*-pyrrole-2,5-dione (128 mg, 0.293 mmol) and Lawesson's reagent (119 mg, 0.293 mmol) were mixed in toluene (4 ml). The mixture was put in the microwave oven at 150 °C for 35 minutes. It was then evaporated to dry. Chromatography of the residue on a column (Isolute® FLASH SI, 70 g/150 ml), using CH_2Cl_2 and then CH_3OH/ CH_2Cl_2 (2:98, then 4:96) as eluant, gave a mixture. Re-chromatography of the mixture on a column (Isolute®

SI, 5g/25 ml), using CH_2Cl_2 and then CH_3CN/ CH_2Cl_2 (10:90 and then 20:80) as eluant, gave 51 mg (38%) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 8.23 (d, J=2 Hz, 1H), 7.73 (bs, 1H), 7.59 (dd, J =8.5, 2 Hz, 1H), 7.15-7.06 (m, 3H), 6.99-6.96 (m, 2H), 6.77-6.73 (m, 2H), 6.66-6.62 (m, 2H), 6.44 (d, J=8.5 Hz, 1H), 6.33 (t, J=74 Hz, 1H), 4.98 (s, 2H) and 4.46 (bs, 2H).

Example 18

1-[(6-Aminopyridin-3-yl)methyl]-3-{[4-(difluoromethoxy)phenyl]amino}-4-phenyl-1*H*-pyrrole-2,5-dithione

1-[(6-Aminopyridin-3-yl)methyl]-3-{[4-(difluoromethoxy)phenyl]amino}-4-phenyl-1*H*-pyrrole-2,5-dione (128 mg, 0.293 mmol) and Lawesson´s reagent (119 mg, 0.293 mmol) were mixed in toluene (4 ml). The mixture was put in the microwave oven at 150 °C for 35 minutes. It was then evaporated to dry. Chromatography of the residue on a column (Isolute® FLASH SI, 70 g/150 ml), using CH_2Cl_2 and then CH_3OH / CH_2Cl_2 (2:98, then 4:96) as eluant, gave an oil mixture. Re-chromatography of the oil on a column (Isolute® SI, 5g/25 ml), using CH_2Cl_2 and then CH_3CN/ CH_2Cl_2 (10:90 and then 20:80) as eluant, gave two products. One of them was further purified by column chromatography (Isolute® SI 1g/6ml, eluted with CH_3CN/ CH_2Cl_2 (10:90)) to give 5 mg (4%) of the title compound. ^1H NMR (400 MHz, $CDCl_3$) δ 8.25 (d, J=2 Hz, 1H), 7.60 (dd, J =8.5, 2 Hz, 1H), 7.33 (bs, 1H), 7.13-7.03 (m, 3H), 6.95-6.92(m, 2H), 6.68-6.62 (m, 4H), 6.43 (d, J= 8.4 Hz, 1H), 6.31(t, J=74 Hz, 1H), 5.44 (s, 2H) and 4.41 (bs, 2H).

Example 19

1-[(6-Aminopyridin-3-yl)methyl]-4-[(4-morpholin-4-ylphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one

1-[(6-Aminopyridin-3-yl)methyl]-3-[(4-morpholin-4-ylphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dione (130 mg, 0.285 mmol) and Lawesson´s reagent (115 mg, 0.285 mmol) were mixed in toluene (50 ml) under nitrogen atmosphere. The mixture was then heated to reflux for 3 days and then evaporated to dryness. Chromatography of the residue on a column (Isolute® FLASH SI, 50g/150 ml), using CH_2Cl_2 and then CH_3OH / CH_2Cl_2 (2:98, then 4:96 and then 8:92) as eluant, gave a mixture. Re-chromatography of the mixture on a column (Isolute® SI, 20g/70 ml), using CH_3CN/ CH_2Cl_2 (20:80, then 50:50) as eluant,

gave 47 mg (35%) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 (d, J= 2 Hz, 1H), 7.78 (s, 1H), 7.58 (dd, J= 8, 2 Hz, 1H), 7.09-7.03 (m, 3H), 6.97-6.94 (m, 2H), 6.58-6.49 (m, 4H), 6.42 (d, J= 8 Hz, 1H), 4.97 (s, 2H), 4.47 (bs, 2H) 3.81-3.78(m, 4H) and 2.99-2.97 (m, 4H).

Example 20

1-[(6-aminopyridin-3-yl)methyl]-3-[(4-morpholin-4-ylphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dithione

1-[(6-Aminopyridin-3-yl)methyl]-3-[(4-morpholin-4-ylphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dione (140 mg, 0.307 mmol) and Lawesson´s reagent (249 mg, 0.614 mmol) were mixed in toluene (4.5 ml). The mixture was put in the microwave oven at 150 °C for 20 minutes and then evaporated to dryness. Chromatography of the residue on a column (Isolute® FLASH SI, 50 g/150 ml), using CH_2Cl_2 and then CH_3OH/ CH_2Cl_2 (2:98, then 4:96 and then 8:92) as eluant, gave a mixture containing 1-[(6-Aminopyridin-3-yl)methyl]-4-[(4-morpholin-4-ylphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one and trace amount of desired product. This mixture was mixed with Lawesson´s reagent (30 mg) in toluene (4 ml). The resulting mixture was put in the microwave oven at 160 °C for 30 minutes and then evaporated to dryness. Chromatography of the residue on a column (Isolute® FLASH SI, 20g/70 ml), using CH_2Cl_2 and then CH_3OH/ CH_2Cl_2 (2:98, and then 4:96) as eluant, gave 4 mg product. Re-chromatography of it on a column (Isolute® FLASH SI, 20g/70 ml), using CH_2Cl_2 and CH_3CN/ CH_2Cl_2 (25:75, then 50:50) as eluant, gave 3 mg product. Re-chromatography of it again on a column (Isolute® SI, 1g/6ml), using CH_2Cl_2 and then CH_3OH/ CH_2Cl_2 (1:99) as eluant, gave 2 mg (1%) of the title compound. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.25 (d, J= 2 Hz, 1H), 7.63 (dd, J= 8.5, 2.2 Hz, 1H), 7.44 (bs, 1H), 7.10-7.01 (m, 3H), 6.95-6.92 (m, 2H), 6.57-6.53 (m, 2H), 6.44-6.41 (m, 3H), 5.44 (s, 2H), 4.44 (bs, 2H) 3.81-3.78(m, 4H) and 2.99-2.96 (m, 4H).

BIOLOGICAL ACTIVITY

CO-ACTIVATOR RECRUITMENT ASSAY

The LBD of human LXRalpha (amino acid 205-447) and LXRbeta (amino acid 216-461) was produced by recombinant techniques in E coli. A fragment of the human Steroid

Receptor Co-Activator-1 (SRC-1) was produced as a synthetic peptide. An anti-6His-antibody coupled with Europium (Eu^{3+}) was used to recognize the His-tag on the LXR-LBD and Allophycocyanin (APC) coupled to streptavidin was used to recognize the biotinylated SRC-1. Agonist binding to LXRalpha or LXRbeta enhances the affinity of LXR towards SRC-1 and thereby brings Eu^{3+} and APC in close proximity. Eu^{3+} is excited at 337 nm and emitts light at 620 nm. This emission, when in close proximity, excites APC to emit light at 665 nm.

Dilution plates with compounds in DMSO were further diluted in buffer (20mM Tris pH 7.5, 0.125% CHAPS, 2mM DTT and 0.05% BSA) in order to reduce DMSO concentration, 0.5 µl to 13.5 µl. To this, 6 µl assay mix was added and the plates (384-well V-groove plates) were incubated at room temperature for 60 to 80 minutes. The assay mix has the following final concentrations; LXRalpha mix: 0.06 µg/ml Eu-labelled anti-6x His Ab, 1.15µg/ml Streptavidin APC, 30 nM SRC-1 peptide and 0.9 µg/ml LXRalpha in buffer and LXRbeta mix; 0.06 µg/ml Eu-labelled anti-6x His Ab, 1.15µg/ml Streptavidin APC, 90 nM SRC-1 peptide and 0.2 µg/ml LXRbeta in buffer. Time-resolved fluorescence readings were done in a Wallac Victor reader at 665 nm followed by reading at 615 nm. The LXR ligand, 22-R Hydroxycholesterol at 50µM was used as the 100 % control.

TRANSACTIVATION ASSAY

Expression vectors were prepared by inserting the ligand binding domain cDNA of human LXRalpha (amino acid 205-447) and LXRbeta (amino acid 216-461) in frame with 3´ to the yeast GAL4 transcription factor DNA binding domain and the nuclear localization signal from the T-antigen of Polyoma Virus in the eucaryotic expression vector pSG5 (Stratagene) . The resulting expression vectors pSGGAL-LXRalpha and pSGGAL-LXRbeta were used in cotransfection experiments together with the pGL3 luciferase reporter plasmid containing a minimal SV40 promoter and five copies of the UAS GAL4 recognition site. 2.5 µg pSGGAL-LXRalpha or beta were mixed with 25 µg pGL3 5xUAS and 22.5 µg pBluscript in 0.95 ml ice cold PBS containing approx. 4-9 milj. U2/OS osteosarcoma cells. After a five minute incubation on ice the cell/DNA mixture was electroporated in 0.4 cm cuvettes at 960 µF, 230 V using a BioRad electroporator and diluted to 0.32 milj cells /ml in complete DMEM medium (Gibco 31966-021). Cells from

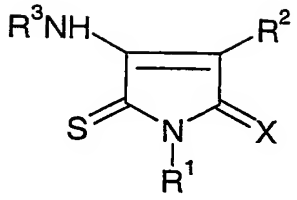
at least two electroporations were pooled in order to avoid variations between different electroportations. 25 µl diluted, electroporated cells, were seeded onto 384-well plates (0.8 x 10^4 cells/well) and the cells were allowed to adhere for 2 h at 37°C, 5 % CO_2 in a cell culture incubator. Dilution plates with compounds in DMSO were further diluted in DMEM w/o phenol red (Gibco 11880-028) including 10% FCS, 1% PEST, 20mM Hepes, 2mM L-Glutamine and 0.36% Glucose (2.5 µl to 97.5 µl) in order to reduce DMSO concentration. 7 µl of this was added to the electroporated cells in 384-well plates and incubation was continued for 48 h in a cell culture incubator, after which cells were lysed by adding 32 µl/well LucLite luciferase substrate. Luciferase activity was measured using the "Luminescence 384 protocol" in the Wallac Victor reader after 15 minutes incubation at room temperature. The LXR ligand, Tularik T0901317, at 1µM was used as the 100 % control.

The compounds of formula I have an EC_{50} of less than 50µmol/l for LXRalpha and/or beta in coactivator recruitment assays and/or reporter gene assays. For example, the compounds of Examples 7 and 18 had EC_{50}s of 0.09µmol/l and 0.14µmol/l in coactivator recruitment assays, respectively.

In addition the compounds of the present invention exhibit improved physical and/or chemical and/or DMPK (Drug Metabolism and Pharmacokinetic) properties, for example they exhibit improved metabolic stability *in vitro*, and/or exhibit favourable pharmacological effects *in vivo*. The compounds also have a promising toxicological profile.

CLAIMS

1. A compound of Formula I



Formula I

wherein:

$\mathbf{R^1}$ is selected from phenyl(1-4C)alkyl, pyridyl(1-4C)alkyl wherein the pyridyl is optionally substituted by amino or $\mathbf{R^1}$ is a (1-6C)alkyl group which is optionally substituted by one or more of the following: fluoro or (1-3C)alkoxy which is optionally substituted by one or more fluoro;

$\mathbf{R^2}$ is phenyl;

$\mathbf{R^3}$ is 4-morpholinophenyl or phenyl optionally substituted by one or more (1-4C)alkoxy groups wherein the alkoxy groups are optionally substituted by one or more fluoro; and

X is O or S and pharmaceutically acceptable salts thereof.

2. A compound according to claim 1 wherein X is O.

3. A compound according to claim 1 wherein X is S.

4. A compound according to any previous claim in which $\mathbf{R^1}$ is selected from methyl, ethyl, propyl, butyl, 2-methoxyethyl, 2,2,2-trifluoroethyl, benzyl, 4-pyridylmethyl, 3-pyridylmethyl or 2-amino-5-pyridylmethyl.

5. A compound according to any previous claim in which $\mathbf{R^3}$ is 4-methoxyphenyl, 4-difluoromethoxyphenyl or 4-morpholinophenyl

6. A compound selected from one or more of the following:

1-(2-Methoxyethyl)-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;

1-(2-Methoxyethyl)-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;

4-[(4-Methoxyphenyl)amino]-3-phenyl-1-(pyridin-3-ylmethyl)-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-3-ylmethyl)-1H-pyrrole-2,5-dithione;

4-[(4-Methoxyphenyl)amino]-3-phenyl-1-(pyridin-4-ylmethyl)-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(pyridin-4-ylmethyl)-1H-pyrrole-2,5-dithione;

1-Butyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;

1-Butyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;

4-[(4-Methoxyphenyl)amino]-3-phenyl-5-thioxo-1-(2,2,2-trifluoroethyl)-1,5-dihydro-2H-pyrrol-2-one;

3-[(4-Methoxyphenyl)amino]-4-phenyl-1-(2,2,2-trifluoroethyl)-1H-pyrrole-2,5-dithione;

1-Benzyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;

1-Benzyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;

4-[(4-Methoxyphenyl)amino]-1-methyl-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one ;

3-[(4-Methoxyphenyl)amino]-1-methyl-4-phenyl-1*H*-pyrrole-2,5-dithione;

1-Ethyl-4-[(4-methoxyphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2H-pyrrol-2-one;

1-Ethyl-3-[(4-methoxyphenyl)amino]-4-phenyl-1H-pyrrole-2,5-dithione;

1-[(6-Aminopyridin-3-yl)methyl]-4-{[4-(difluoromethoxy)phenyl]amino}-3-phenyl-5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one;

1-[(6-Aminopyridin-3-yl)methyl]-3-{[4-(difluoromethoxy)phenyl]amino}-4-phenyl-1*H*-pyrrole-2,5-dithione;

1-[(6-Aminopyridin-3-yl)methyl]-4-[(4-morpholin-4-ylphenyl)amino]-3-phenyl-5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one and

1-[(6-aminopyridin-3-yl)methyl]-3-[(4-morpholin-4-ylphenyl)amino]-4-phenyl-1*H*-pyrrole-2,5-dithione;

and pharmaceutically acceptable salts thereof.

7. A pharmaceutical formulation comprising a compound according to any one of claims 1-6 in admixture with pharmaceutically acceptable adjuvants, diluents and/or carriers.

8. A method of treating or preventing lipid disorders (dyslipidemia) whether or not associated with insulin resistance comprising the administration of a compound according to any one of claims 1-6 to a mammal in need thereof.

9. The use of a compound according to any one of claims 1-6 in the manufacture of a medicament for the treatment of lipid disorders (dyslipidemia) whether or not associated with insulin resistance.

10. A method of treating or preventing atherosclerosis comprising the administration of an effective amount of a compound of formula I according to any one of claims 1-6 to a mammal in need thereof.

11. A pharmaceutical composition comprising a compound as claimed in any one of claims 1 to 6 combined with another therapeutic agent that is useful in the treatment of disorders associated with the development and progress of atherosclerosis such as hypertension, hyperlipidaemias, dyslipidaemias, diabetes and obesity.

ABSTRACT

The present invention relates to certain novel, substituted 5-thioxo-1,5-dihydro-2*H*-pyrrol-2-one and 1*H*-pyrrole-2,5-dithione derivatives, to processes for preparing such compounds, to their the utility in treating clinical conditions including atherosclerosis, lipid disorders (dyslipidemias) whether or not associated with insulin resistance and other manifestations of the metabolic syndrome, to methods for their therapeutic use and to pharmaceutical compositions containing them.